0.44 waves/cm, a Strehl value of 0.94. These parameters were measured by a Zygo Fizeau interferometer.

Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein

CLAIMS

1. A method for forming a multilayer optical article comprising:

grasping an outer surface of a first substrate with a first holder, whereby the outer surface of the first substrate is held to an inner surface of the first holder;

grasping an outer surface of a second substrate with a second holder, whereby the outer surface of the second substrate is held to an inner surface of the second holder;

arranging the inner surfaces of the first and second holders to face one another in a selected angular relationship;

inserting an optical article between the first and second substrate, wherein a first layer of adherent is between a first surface of the optical article and the inner surface of the first substrate, and a second layer of adherent is between a second surface of the optical article and the inner surface of the second substrate;

moving the first and second holders toward each other such that the inner surfaces of the first and second substrates contact the first and second layer of adherent with the optical article in between the first and second layer of adherent; and

at least partially curing the adherent while the inner surfaces of the first and second holders are in the selected angular relationship to form a multilayer article encasing the optical article, wherein after removal of the first and second holder, the at least partially cured adherent maintains the multilayer article containing the optical article in the posture at which the multilayer article was held by the first and second holders.

2. The method of claim 1, wherein said step of inserting an optical article between the first and second substrate comprises:

disposing an adherent on the inner surface of the first substrate or the inner surface of the second substrate;

inserting a previously formed optical article on the adherent; and

disposing an adherent on the surface of the previously formed optical article.

3. The method of claim 2, wherein said step of disposing an adherent comprises drawing in via capillary action an adherent.

4. The method of claim 2, wherein said step of disposing an adherent comprises injecting, extruding, pouring, pipetting, roll coating, blade coating, or spraying an adherent.

5. The method of claim 2, wherein the step of disposing an adherent on the inner surface of the first substrate or the inner surface of the second substrate comprises dispensing the adherent through a hole in the first or second substrate via a corresponding hole in the first or second holder.

6. The method of claim 1, wherein the outer surface of a substrate is held to an inner surface of a holder using a vacuum force.

7. The method of claim 1, wherein the outer surface of a substrate is held to an inner surface of a holder using an electromagnetic force.

8. The method of claim 1, wherein the holders are transparent plates.

9. The method of claim 1, wherein the holders have at least one vacuum groove therein for applying a vacuum force to a substrate.

10. The method of claim 1, wherein the holders have at least one hole for dispensing an adherent through the holder.

11. The method of claim 1, wherein the substrates are made from glass, silicon, polycarbonate, polymethylmethacrylate, acrylic, or any combination thereof.

12. The method of claim 1, wherein the substrates have at least one hole for dispensing an adherent through the substrate.

13. The method of claim 1, wherein the geometric form of the substrates may be square, rectangular, circular, or oval.

14. The method of claim 1, wherein the substrates are about 25 micrometers to about 3 millimeters in thickness.

15. The method of claim 1, wherein the outer surface of the first or second substrates contain surface relief patterns.

16. The method of claim 1, wherein the inner surface of the first or second substrate contain a surface relief pattern or a diffractive grating.

17. The method of claim 1, wherein the first or second substrate is an optical article.

18. The method of claim 17, wherein the optical article is a polarizer, half wave plate, quarter wave plate, or neutral density filter.

19. The method of claim 1, further comprising the step of cleaning the inner or outer surface of the first or second substrate before grasping by the first or second holder.

20. The method of claim 19, wherein the step of cleaning comprises:

applying a cleaning solvent to the surface of the substrate; and

evaporating the solvent by spinning the substrate.

21. The method of claim 1, wherein the multilayer article encasing the optical article has an average surface flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to 1600 nanometers.

22. The method of claim 1, wherein the multilayer article encasing the optical article has an average transmission flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to 1600 nanometers.

23. The method of claim 1, wherein the adherent is cured utilizing thermal or radiation energy.

24. The method of claim 23, further comprising the use of heat to accelerate curing of the radiation energy.

25. The method of claim 1, wherein the inserted optical article is a polarizer, birefringent plate, diffractive optic, neutral density filter, half wave plate, or quarter wave plate.

26. The method of claim 9, wherein the multilayer article is released from the holders by injecting a gas into the holder vacuum grooves.

27. The method of claim 1, wherein the selected angular relationship is a parallel relationship.

28. The method of claim 1, wherein the multilayer article has a Strehl value of 0.9 or greater.

29. The method of claim 1, wherein during the curing step either the first or second holder is allowed to move along a z-axis.

30. A method for forming a multilayer optical article comprising:

grasping an outer surface of a substrate with a first holder, whereby the outer surface of the substrate is held to an inner surface of the first holder;

arranging the inner surfaces of a second holder and the first holder to face one another in a selected angular relationship;

inserting an optical article between the substrate and the second holder, wherein a first layer of adherent is between a first surface of the optical article and the inner surface of the substrate, and a second layer of adherent is between a second surface of the optical article and the inner surface of the second holder;

moving the first and second holders toward each other such that the inner surfaces of the substrate and second holder contact the first and second layer of adherent with the optical article in between the first and second layer of adherent; and

at least partially curing the adherent while the inner surfaces of the first and second holders are in the selected angular relationship to form a multilayer article encasing the optical article, wherein after removal of the first and second holder, the at least partially cured adherent maintains the multilayer article containing the optical article in the posture at which the multilayer article was held by the first and second holders.

31. The method of claim 30, wherein said step of inserting an optical article between the substrate and second holder comprises:

disposing an adherent on the inner surface of the substrate;

inserting an optical article on the adherent; and

disposing an adherent on the surface of the previously formed optical article.

32. The method of claim 31, wherein said step of disposing an adherent comprises drawing in via capillary action an adherent.

33. The method of claim 31, wherein said step of disposing an adherent comprises injecting, extruding, pouring, pipetting, roll coating, blade coating, or spraying an adherent.

34. The method of claim 31, wherein the step of disposing an adherent on the inner surface of the substrate comprises dispensing the adherent through a hole in the substrate via a corresponding hole in the first or second holder.

35. The method of claim 30, wherein the outer surface of the substrate is held to an inner surface of a holder using a vacuum force.

36. The method of claim 30, wherein the outer surface of the substrate is held to an inner surface of a holder using an electromagnetic force.

37. The method of claim 30, wherein the holders are transparent plates.

38. The method of claim 30, wherein the holders have at least one vacuum groove therein for applying a vacuum force to the substrate.

39. The method of claim 30, wherein the holders have at least one hole for dispensing an adherent through the holder.

40. The method of claim 30, wherein the substrate is made from glass, silicon, polycarbonate, polymethylmethacrylate, acrylic, or any combination thereof.

41. The method of claim 30, wherein the substrate has at least one hole for dispensing an adherent through the substrate.

42. The method of claim 30, wherein the geometric form of the substrate may be square, rectangular, circular, or oval.

43. The method of claim 30, wherein the substrate is about 25 micrometers to about 3 millimeters in thickness.

44. The method of claim 30, wherein the outer surface of the substrate contains surface relief patterns.

45. The method of claim 30, wherein the inner surface of the substrate contains a surface relief pattern or a diffractive grating.

46. The method of claim 30, wherein the substrate is an optical article.

47. The method of claim 46, wherein the optical article is a is a polarizer, neutral density filter, half wave plate, or quarter wave plate.

48. The method of claim 30, further comprising the step of cleaning the inner or outer surface of the substrate before grasping by the first holder.

49. The method of claim 48, wherein the step of cleaning comprises:

applying a cleaning solvent to the surface of the substrate; and

evaporating the solvent by spinning the substrate.

50. The method of claim 30, wherein the multilayer article encasing the optical article has an average surface flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to 1600 nanometers.

51. The method of claim 30, wherein the multilayer article encasing the optical article has an average transmission flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to 1600 nanometers.

52. The method of claim 30, wherein the adherent is cured utilizing thermal or radiation energy.

53. The method of claim 52, further comprising the use of heat to accelerate curing of the radiation energy.

54. The method of claim 30, wherein the inserted optical article is a polarizer, birefringent plate, or diffractive optic.

55. The method of claim 35, wherein the multilayer article is released from the holders by injecting a gas into the holder vacuum grooves.

56. The method of claim 30, wherein the selected angular relationship is a parallel relationship.

57. The method of claim 30, wherein the multilayer article has a Strehl value of 0.9 or greater.

58. The method of claim 30, wherein during the curing step either the first or second holder is allowed to move along a z-axis.

59. A method for forming a multilayer optical article comprising:

disposing a first adherent on an inner surface of a first holder;

inserting an optical article on the first adherent;

disposing a second adherent on the surface of the previously formed optical article;

moving the first and second holders toward each other such that the second holder contacts the second adherent with the optical article in between the first and second layer of adherent; and

at least partially curing the adherent while the inner surfaces of the first and second holders are in a selected angular relationship to form a multilayer article encasing the optical article, wherein after removal of the first and second holder, the at least partially cured adherent maintains the multilayer article containing the optical article in the posture at which the multilayer article was held by the first and second holders.

60. The method of claim 59, wherein said step of disposing an adherent comprises drawing in via capillary action an adherent.

61. The method of claim 59, wherein said step of disposing an adherent comprises injecting, extruding, pouring, pipetting, roll coating, blade coating, or spraying an adherent.

62. The method of claim 59, wherein the multilayer article encasing the optical article has an average surface flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to 1600 nanometers.

63. The method of claim 59, wherein the multilayer article encasing the optical article has an average transmission flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to 1600 nanometers.

64. The method of claim 59, wherein the adherent is cured utilizing thermal or radiation energy.

65. The method of claim 64, further comprising the use of heat to accelerate curing of the radiation energy.

66. The method of claim 59, wherein the inserted optical article is a polarizer, birefringent plate, or diffractive optic.

67. The method of claim 59, wherein the selected angular relationship is a parallel relationship.

68. The method of claim 59, wherein the multilayer article has a Strehl value of 0.9 or greater.

69. The method of claim 59, wherein during the curing step either the first or second holder is allowed to move along a z-axis.

70. A multilayer article comprising:

a first substrate;

a second substrate;

an article located between the first substrate and the second substrate;

a first layer of partially cured adherent, wherein the first layer of partially cured adherent is disposed between the first substrate and the article; and

a second layer of partially cured adherent, wherein the second layer of partially cured adherent is disposed between the second substrate and the article.

71. The multilayer article of claim 70, wherein the multilayer article has a surface flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to 1600 nanometers and a transmission flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to

1600 nanometers, wherein the force exerted by the adherents on the first and second substrates maintains the surface and transmission flatness.

72. The multilayer article of claim 70, wherein the substrates are made from glass, silicon, polycarbonate, polymethylmethacrylate, acrylic, or any combination thereof.

73. The multilayer article of claim 70, wherein the substrates have at least one hole for dispensing an adherent through the substrate.

74. The multilayer article of claim 70, wherein the geometric form of the substrates may be square, rectangular, circular, or oval.

75. The multilayer article of claim 70, wherein the substrates are about 25 micrometers to about 3 millimeters in thickness.

76. The multilayer article of claim 70, wherein the outer surface of the first or second substrates contain surface relief patterns.

77. The multilayer article of claim 70, wherein the inner surface of the first or second substrate contain a surface relief pattern or a diffractive grating.

78. The multilayer article of claim 70, wherein the first or second substrate is an optical article.

79. The multilayer article of claim 70, wherein the article is a polarizer, half wave plate, quarter wave plate, or neutral density filter, birefringent plate, or diffractive optic.

80. The multilayer article of claim 70, wherein the adherent is cured utilizing thermal or radiation energy.

81. The multilayer article of claim 70, wherein the article has a Strehl value of 0.9 or greater.

82. A multilayer article comprising:

a substrate;

an article;

a first layer of at least partially cured adherent, wherein the first layer of adherent is disposed between the substrate and a first surface of the article;

a second layer of at least partially cured adherent, wherein the second layer of adherent is disposed on a second surface of the article.

83. The method of claim 82, wherein the multilayer article has a surface flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to 1600 nanometers and a transmission flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to

1600 nanometers, wherein the force exerted by the adherent on the first substrate maintains the surface and transmission flatness.

84. The multilayer article of claim 82, wherein the substrate is made from glass, silicon, polycarbonate, polymethylmethacrylate, acrylic, or any combination thereof.

85. The multilayer article of claim 82, wherein the substrate has at least one hole for dispensing an adherent through the substrate.

86. The multilayer article of claim 82, wherein the geometric form of the substrate may be square, rectangular, circular, or oval.

87. The multilayer article of claim 82, wherein the substrate is about 25 micrometers to about 3 millimeters in thickness.

88. The multilayer article of claim 82, wherein the outer surface of the substrate contains a surface relief pattern.

89. The multilayer article of claim 82, wherein the inner surface of the substrate contains a surface relief pattern or a diffractive grating.

90. The multilayer article of claim 82, wherein the substrate is an optical article.

91. The multilayer article of claim 82, wherein the article is a polarizer, half wave plate, quarter wave plate, neutral density filter, birefringent plate, or diffractive optic.

92. The multilayer article of claim 82, wherein the adherent is cured utilizing thermal or radiation energy.

93. The multilayer article of claim 82, wherein the multilayer article has a Strehl value of 0.9 or greater.

94. A multilayer article comprising:

an article;

a first layer of at least partially cured adherent, wherein the first layer of adherent is disposed on a first surface of the article;

a second layer of at least partially cured adherent, wherein the second layer of adherent is disposed on a second surface of the article, and the multilayer article has a surface flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to 1600 nanometers and a transmission flatness of about 0.05 waves/cm to about 1 wave/cm at wavelengths of about 300 nanometers to 1600 nanometers.

95. The multilayer article of claim 94, wherein the article is a polarizer, half wave plate, quarter wave plate, neutral density filter, birefringent plate, or diffractive optic.

96. The multilayer article of claim 94, wherein the adherent is cured utilizing thermal or radiation energy.

97. The multilayer article of claim 94, wherein the multilayer article has a Strehl value of 0.9 or greater.